

THE ACTIVE MARKER COMPOUND IDENTIFICATION OF *ARTOCARPUS CHAMPEDEN* SPRENG. STEMBARK EXTRACT, MORACHALCHONE A AS ANTIMALARIAL

ACHMAD FUAD HAFID^{1*}, NI PUTU ARIANTARI², LIDYA TUMEWU³, AGRIANA ROSMALINA HIDAYATI⁴,
ATY WIDYAWARUYANTI¹

¹Departement of Pharmacognosy and Phytochemistry, Faculty of Pharmacy, Airlangga University, Jalan Dharmawangsa Dalam, Surabaya 60286, Indonesia, ²Departement of Pharmacy, Faculty of Mathematics and Natural Science, Udayana University, Bali, Indonesia, ³Institute of Tropical Disease, Airlangga University, Surabaya, Indonesia, ⁴Department of Pharmacology, Faculty of Medicine, Mataram University, Mataram, Indonesia. Email: achmadfuad@unair.ac.in

Received: 16 July 2012, Revised and Accepted: 29 Aug 2012

ABSTRACT

Artocarpus champeden Spreng. (Moraceae), commonly known as "cempedak", has been traditionally used for malarial remedies. Several studies reported that *A. champeden* Spreng. stem bark has *in vitro* and *in vivo* antimalarial activity. The main aim of this research was to isolate and identify an active marker compound of *A. champeden* stem bark for quality control purpose of *A. champeden* stem bark extract in the development of this extract as phytomedicine antimalarial product. The isolation method was bioactivity guided column chromatography and preparative TLC techniques. The marker compound that has been isolated showed potent antimalarial activity with an IC₅₀ value of 0.18 µg/ml against *Plasmodium falciparum* 3D7 strain. Based on UV, IR, ¹H NMR, ¹³C NMR, 2D NMR (COSY, HMBC and HMQC) spectral and identification of other references, the active marker compound was identical with known prenylated chalcone compound, Morachalcone A.

Keywords: *Artocarpus champeden* Spreng., Antimalarial, Morachalcone A, Active marker compound.

INTRODUCTION

Artocarpus champeden Spreng, commonly known as "cempedak", belongs to Moraceae. It is widely distributed in Indonesia and has been traditionally used for malarial remedies³. Previous studies reported that several prenylated flavonoids isolated from *A. champeden* Spreng. have potential *in vitro* antimalarial activity against *P. falciparum* 3D7 strain¹⁴ and *in vivo* against *P. berghei* strains ANKA (unpublished). This indicates that *A. champeden* Spreng. is prospective to be developed as phytomedicine product for antimalarial.

The pharmaceutical requirements for a herbal product destined for a multi-target therapy are very complex⁴. The constituents of medicinal herbs can vary greatly as a result of genetic factors, climate, soil quality and other external factors¹². Therefore, despite the use of authenticated botanical voucher specimens to help assure proper identity, modern concepts and methods relating to the quality (i.e., chemical consistency) of herbal materials and products pertain to phytochemical markers and fingerprint analyses are needed. These markers are the threads that tie together the production and the quality control¹¹. Ideally, chemical markers should be unique components that contribute to the therapeutic effects of a herbal medicine⁶. Markers should be commercially available or able to be isolated in own laboratory as well¹¹.

The standardized extract should have consistent constituent in order to ensure the consistency of quality, safety, and efficacy of the product. The marker approach to ensure consistency is based upon the assumption that the content of other constituents will vary in proportion to the marker compound. If each batch contains the same standardize amount of marker, the content of other constituents will also be relatively consistent^{5,8,15}.

In order to develop *A. champeden* as antimalarial phytomedicine product with multi-component approach, it is needed to standardize *A. champeden* extract as raw material. Therefore, the study to obtain standardized extract of *A. champeden* Spreng. stem bark as raw material of antimalarial phytomedicine product using active marker compound was conducted.

The present study aims to isolate and determine marker compound from 80% ethanol extract of *A. champeden* stem bark. This study consists of several steps; marker compound isolation using chromatography techniques, followed by identification of isolate based on UV-Vis, IR, ¹H NMR, ¹³C NMR, 2D NMR (COSY, HMBC and

HMQC) and MS spectra. Marker isolation from ethanol extract of *A. champeden* stem bark was done by bioactivity guided fractionation.

MATERIAL AND METHODS

General Experimental Techniques

Silica gel was used for column chromatography (Merck, 0.063-0.200 mm) and preparative thin layer chromatography (Merck). Spots on plates were detected under UV light (λ 254 and 366 nm) and by sprayed 10% H₂SO₄ in water followed by gentle heating. IR spectrum obtained in a Shimadzu spectrometer IR Prestige-21 type. The NMR experiments (both 1D and 2D) were obtained in a Jeol spectrometer ECA 500 type operating at 500 MHz. HPLC analysis was performed with Hewlett Packard Agilent 1100 series, an Agilent 1100 series Degasser G1322A, a Rheo-dyne 7725 injection valve with a 20-µL loop, Agilent 1100 series Quaternary Pump G1311A, Agilent 1100 series Column Compartment G1316A, Agilent 1100 series diodearray detector (DAD) G1315A. Compounds were separated in a 250x4.6 mm Varian Microsorb MV 100-5 C8 column.

Plant material

The stem bark of *Artocarpus champeden* Spreng. was collected from Bogor, West Java, Indonesia, on June 2007 and 2008. A voucher specimen was identified and deposited at the Herbarium Bogoriense, Bogor Botanical Garden, Bogor, Indonesia.

Extraction and Isolation

One kilogram of *Artocarpus champeden* Spreng. stem bark was extracted with 80% ethanol at 60°C, yielded 74,64 g of crude extract. This extract was applied to ODS column chromatography, using MeOH-H₂O (4:1 v/v)-MeOH-acetonitril (1:1 v/v) and acetonitril as eluent, resulting in 10 major fractions (fraction 1-10). Fraction 4 (686.9 mg) was applied to silica gel column and eluted with CHCl₃ followed by increasing polarity of CHCl₃-MeOH 1-10% by gradient elution, yielded 9 major subfraction. Further separation of subfraction 4.8 (47.1 mg) was conducted by several steps of Preparative TLC techniques using silica RP-18 as stationary phase with MeOH-H₂O (7:3 v/v) as mobile phase yielded active subfraction 4.8.8 (18.7 mg). The process was then continued using silica as stationary phase with CHCl₃-MeOH (9.5:0.5 v/v) as mobile phase yielded active subfraction 4.8.8.7 (12.2 mg).

Purification of this subfraction was conducted by reverse-phase PTLC with MeOH-H₂O (4:1 v/v) as mobile phase resulting an active marker compound, Morachalcone A (7.2 mg).

Morachalcone A: orange powder; UV (MeOH) λ_{\max} nm 250, 316 and 385; IR (KBr) cm^{-1} : 3,456, 1,697. ^1H and ^{13}C NMR data are given in Table 1.

Antimalarial activity Assay

The antimalarial activity of fractions and the isolated compound were determined by the procedure described by Budimulya *et al.* (1997). In brief, each fraction or compound was separately dissolved in DMSO (10^{-2} mol L^{-1}) and kept at -20°C until used. The malarial parasite *P. falciparum* 3D7 strain was propagated in a 24-well culture plate in the presence of a wide range of concentration of each fractions or compound. The growth of the parasite was monitored by making a blood smear fixed with MeOH and stained with Giemsa stain. The antimalarial activity of each fraction or compound was expressed as an IC_{50} value, defined as the concentration of the compound causing 50% inhibition of parasite growth relative to an untreated control.

HPLC Conditions

HPLC analysis was conducted using methanol-water (65:35 v/v) as mobile phase by isocratic elution, C8 250x4.6 mm Varian Microsorb MV 100-5 column at flow rate of 1 ml/minute, column temperature of 30°C , stop time of analysis at 20 minutes and detection wavelength set at 385 nm.

Sample preparation

10 mg of ethanol extract of *A. champeden* Spreng stem bark was accurately weighed and dissolved in methanol using vortex for 5 minutes. Sample solution was filtered through a $0.45\ \mu\text{m}$ syringe membrane filter.

RESULT AND DISCUSSION

The dried stem bark of *A. champeden* was extracted by 80% ethanol. In a preliminary test of in vitro antimalarial activity against *P. falciparum* 3D7 clone of this ethanol extract showed significant inhibition. Isolation of active marker compound from ethanol extract of *A. champeden* stem bark was done by bioactivity guided isolation. The ethanol extract was fractionated by open column chromatography using ODS as stationary phase and methanol-water as mobile phase, resulting in 10 major fractions and fraction 4 was active against *P. falciparum* 3D7 strains. Furthermore, fraction 4 was applied to silica gel column and eluted with CHCl_3 followed by

increasing polarity of CHCl_3 -MeOH 1-10%, yielded active subfraction 4.8 with an IC_{50} value of $0.03\ \mu\text{g mL}^{-1}$. Further separation of subfraction 4.8 with several steps of PTLC techniques using RP-18 silica gel as stationary phase with MeOH- H_2O as mobile phase yielded active subfraction 4.8.8 (IC_{50} value of $0.10\ \mu\text{g mL}^{-1}$), then silica as stationary phase with CHCl_3 -MeOH mixtures as mobile phase yielded active subfraction 4.8.8.7 (IC_{50} value of $0.39\ \mu\text{g mL}^{-1}$). Purification of this subfraction by reverse-phase PTLC with MeOH- H_2O as mobile phase resulting in active marker compound.

The identification of isolated compound was based on UV-Vis, IR, ^1H NMR, ^{13}C NMR, 2D NMR (COSY, HMBC and HMQC) spectra and comparison of other references. Marker compound was isolated as orange powder. The UV-Vis absorptions at 250, 316 and 385 nm were suggestive of a chalcone skeleton⁷. The IR spectrum of morachalcone A contained absorption bands at $3,456\ \text{cm}^{-1}$ and $1,697\ \text{cm}^{-1}$ corresponding to hydroxyl and carbonyl groups, respectively¹³. The ^1H NMR spectrum contained characteristic signals ascribable to an isoprenyl group (δ H 1.65, 1.77, 5.22, 3.34). 2 proton signals at δ H 7.73 (1H, dd, $J=15.25$ Hz) and 8.1 (1H, dd, $J=15.9$ Hz) form an AB system, the large coupling constant indicating the trans geometry of a double bond. The ^1H -NMR spectrum (table 1) also indicated signals for ortho coupled aromatic protons in ring A (δ 6.36 (2H, m) dan δ 7.52 (1H, dd, $J=8.55, 3.7$ Hz) and two aromatic protons in ring B δ 6.43 (1H, q, $J=8.55, 17.75$ Hz) dan δ 7.76 (1H, d, $J=8.55$ Hz). The presence of proton signals at δ 13.93 and δ 14.48 indicated that the hydroxyl groups are located at C-2 and C-4 in ring A and C-2' and C-4' in ring B. The ^{13}C -NMR spectrum contained signals from 20 carbon atoms including that of a ketone carbonyl carbon at δ_c 194.25 (table 1).

On the basis of HMQC and HMBC spectral analysis, all protons and carbon signals were fully assigned and the positions of the substituents on the aromatic rings were determined. The HMBC correlations for H-1''/C-2', C-3', and C-3'' confirmed that the 3,3-dimethylallyl group was located at C-3'.

The structure determination for marker compound also conducted based on the comparison of their spectroscopic data from literature values^{1,9,10}. Thus, the structure of marker compound was deduced as known prenylated chalcone, Morachalcone A. Morachalcone A was previously isolated from callus culture of *Maclura pomifera* (Moraceae)⁹ and also from methanol extract of *A. champeden* stem bark (unpublished).

Table 1. The ^1H NMR and ^{13}C NMR (500 MHz) data for marker compound

C	^1H	^{13}C
α	7.73 dd, (15.25 Hz)	117.93
β	8.1 dd (15.9 Hz)	142.15
C=O	-	194.25
1'	-	114.68
2'	-	163.50
3'	-	116.62
4'	-	165.32
5'	6.43 q (8.55, 17.75 Hz)	108.26
6'	7.76 d (8.55 Hz)	130.47
1	-	115.74
2	-	160.85
3	6.36 m	103.69
4	-	162.77
5	6.36 m	109.23
6	7.52 dd (8.55, 3.7 Hz)	132.56
CH ₂	3.34	22.60
CH=	5.22	123.70
C=	-	131.59
E-Me	1.65 s	26.09
Z-Me	1.77 s	18.04

*CD₃OD, TMS as internal standard.

Only signals that are significant to the comparison are reported.

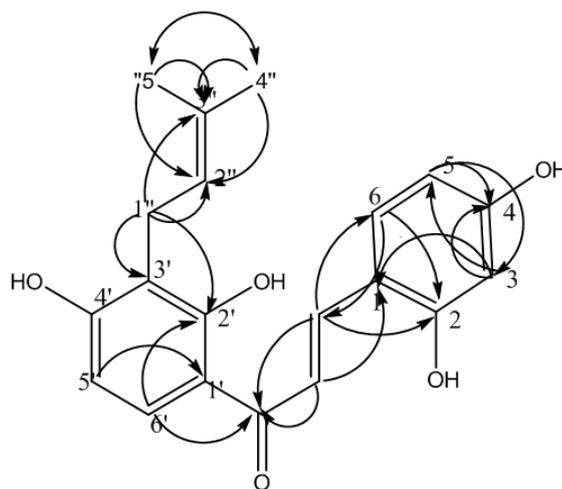


Fig. 1: The chemical structure of active marker compound isolated from *Artocarpus champeden* Spreng.

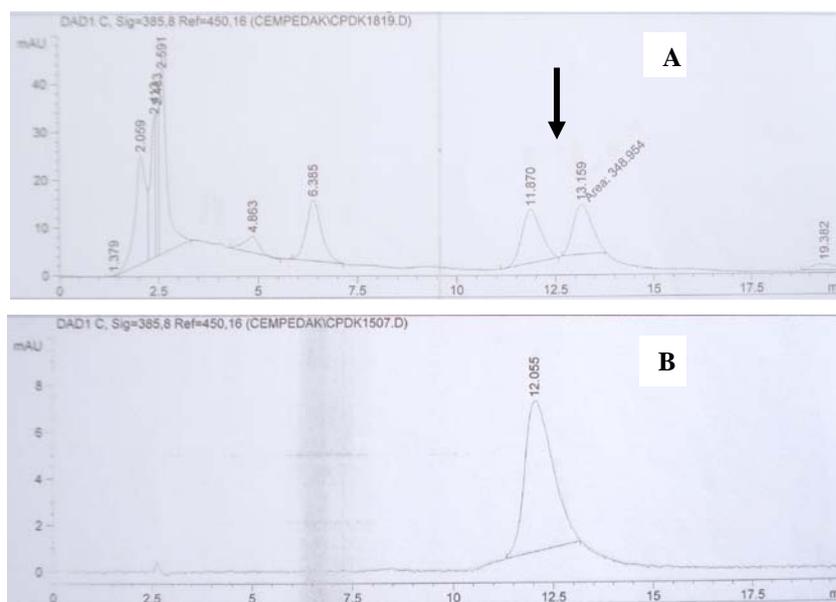


Fig. 2: Chromatogram obtained from ethanol extract of *A. champeden* stem bark (A) and marker standard morachalcone A (B)

The marker compound revealed inhibitory activity against *P. falciparum* 3D7 strain with an IC_{50} value of $0.18 \mu\text{g mL}^{-1}$. The inhibitory activity of this compound showed that the isolated compound was an active marker.

According to Reif [2004], marker compound should be accessible to the quantification of common analytical equipment (e.g., high-performance liquid chromatography [HPLC]) to keep costs of routine analysis moderate. Therefore, preliminary analysis of the existence of Morachalcone A in ethanol extract of *A. champeden* Spreng. stem bark was conducted using HPLC.

The chromatogram profile of ethanol extract using the mixture of methanol and water (65:35 v/v) as mobile phase by isocratic elution, C8 250x4.6 mm Varian Microsorb MV 100-5 column at flow rate of 1 mL/minute, column temperature of 30°C , stop time of analysis at 20 minutes and detection wavelength set at 385 nm (Figure 2) showed that peak at time retention shown as Mean \pm SD (RSD) of 13.001 minutes \pm 0.37 (2.87%), has resolution of 1.42, plate number of 3524, peak width at half height of 0.5200, symmetry factor of 0.82 and selectivity factor of 1.11. The purity factor of this peak was 997.034, indicated that targeted peak fall within acceptable purity. The identity of this peak against marker spectrum

was shown as match factor value of 981.261 (>950.000), indicated that targeted peak analyzed in ethanol extract was marker compound that has been detected in ethanol extract of *A. champeden* stem bark.

The result of this study showed that the active marker compound, Morachalcone A, can be used as a marker compound in standardization of ethanol extract of *A. champeden* stem bark as antimalarial phytomedicine product. Further studies are needed to develop an analysis method of Morachalcone A for quality control and standardization purpose of ethanol extract of *A. champeden* Spreng.

ACKNOWLEDGEMENT

This work was supported by Grant for Competitive Research (no. 564/J03.2/PG/ 2007) from DGHE, The Ministry of National Education, Republic of Indonesia.

REFERENCES

1. Abegaz BM, Ngandjui BT, Dongo E, Tamboue H. Prenylated Chalcones and Flavones from The Leaves of *Dorstenia kameruniana*. *Phytochemistry*. 1998, 49(4): 1147-1150

2. Budimulya AS, Syafruddin, Tapchaisri P, Wilariat P, Marzuki S. The sensitivity of Plasmodium protein synthesis to prokaryotic ribosomal inhibitors. *Mol Biochem Parasitol* . 1997, 84:137-141
3. Hakim EH, Achmad SA, Juliawaty LD, Makmur L, Syah YM, Aimi N, Kitajima M, Takayama H, Ghisalberti E. Prenylated Flavonoids and Related Compounds of The Indonesian *Artocarpus* (Moraceae). *J Nat Med*. 2006, 60: 161-184
4. Kroll U, Cordes C. Pharmaceutical prerequisites for a multi-target therapy. *Phytomedicine*. 2006, 13: 12-19
5. Lazarowych NJ, Pekos P. Use of Fingerprinting and Marker Compounds for Identification and Standardization of Botanical Drugs: Strategies for Applying Pharmaceutical HPLC Analysis to Herbal Product. *Drug Information Journal*. 1998, 32: 497-512
6. Li S, Han Q, Qiao C, Song J, Chen, CL, Xu H. Chemical Markers for The Quality Control of Herbal Medicine: An Overview. *Chinese Medicine*. 2008, 3(7): 1-16
7. Mabry TJ, Markham KR, Thomas MB. *The Systematic Identification of Flavonoids*. Springer-Verlag, New York-Heidelberg-Berlin. 1970, pp 227-241
8. McCutcheon AR. *An Exploration of Current Issues in Botanical Quality: A Discussion Paper*. Canada: Natural Health Products. 2002, pp 1-11
9. Monache GD, De Rosa MC, Scurria R, Vitali A, Cuteri A, Monacelli B, Pasqua G, Botta B. Comparison Between Metabolite Productions in Cell Culture and in Whole Plant of *Maclura pomifera*. *Phytochemistry*. 1995, 39(3): 575-580
10. Satish C. Sati, Maneesha D. Sati, Amita Sharma, Madhuri Joshi. Isolation and characterisation of Phenolic from the roots of *Cotoneaster acuminatus* and determination of their Antimicrobial activity, *International J. of Pharmacy and Pharmaceutical Sciences*, 2010, 2(4): 58-60
11. Reif K, Sievers H, Steffen JP. The Role of Chemical Reference Standards as Analytical Tools in the Quality Assessment of Botanical Materials - An European Perspective. *HerbalGram*. 2004, 63: 38-43
12. Schulz V, Hansel R, Blumenthal M, Tyler VE. *Rational Phytotherapy: Reference Guide for Physicians and Pharmacists*. Fifth Edition. Springer-Verlag, Hiedelberg. 2004, pp 1-10
13. Silverstein RM, Bassler GC, Morrill TC. *Spectrometric Identification of Organic Compounds*. John Wiley & Sons Inc, Singapore. 1991, pp 3-10; 91-97
14. Widyawaruyanti A, Subehan, Kalauni SK, Awale S, Nindatu M, Zaini NC, Syafruddin D, Asih PBS, Tezuka Y, Kadota S. New Prenylated Flavones from *Artocarpus champeden* Spreng. and Their Antimalarial Activity In Vitro. *J Nat.Med*. 2007, 61: 410-413
15. SK Rasool, D V Naik, D Prasad Babu, Buchi N. Nalluri. RP-HPLC method for the estimation of Valcyclovir in bulk and pharmaceutical formulations, *International J. of Pharmacy and Pharmaceutical Sciences*, 2012, 4(1): 214-218.